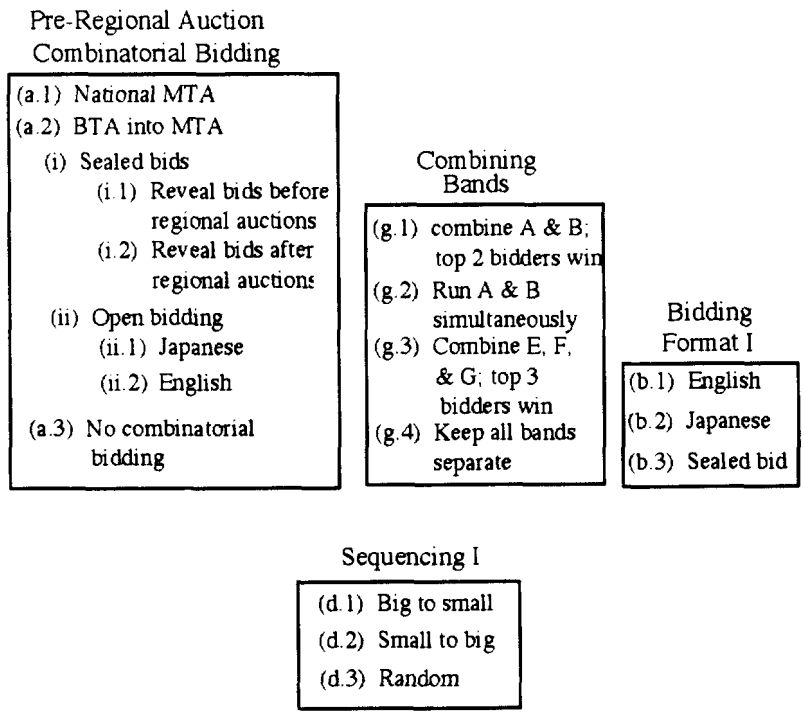
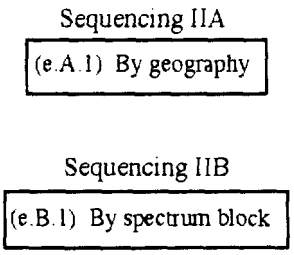
by allowing simultaneous bidding for all BTA licenses within an MTA. In the case where there are 10 BTAs within an MTA, this could result in allowing 40 licenses to be sold simultaneously. The FCC could also limit the aggregation to 5 BTAs or 20 licenses. The complication is that it is difficult but not impossible to imagine simultaneous bidding on 20 licenses without the use of some electronic devices. We could imagine that a scoreboard lists the top bids for each of the four bands within each of the BTAs and the bidder can enter any bid electronically at any time. Bidding stops when no one is willing to increase the bid on any license within a pre-specified period of time. We leave this idea intentionally vague. It is difficult to design simultaneous bidding auctions. Our point is only that if the FCC wishes to experiment with simultaneous bidding across regions (as opposed to across licenses within an region), the most sensible place to experiment is the BTA licenses within an MTA.

Options for a Sequential Auction

At this point, we turn to a discussion of the various options for sequential auction design, focusing on the issue of combinatorial bidding for a national license prior to the regional bidding.





Discussion of national combinatorial bidding (a.1).

The points against national bidding include:

1. The free-rider problem combined with first-price sealed bid for national licenses gives national bidders an advantage (see comments of Professors Milgrom and Wilson). A national bidder could win even if this is inefficient; the national bidder has a value above the second-highest sum but not above the first-highest sum. To state this another way, regional bidders are only able to bid against each other; the free-rider problem prevents them from competing against a national bidder. But national bidders compete against other national bidders and against regional bidders. This biases the auction result towards national bidders.

We propose a modification of the national bidding that solves this problem.

2. Allowing national bidding facilitates the creation of a national network.

This argument is not about auction design per se, but rather the question of national licenses. If we agree that a national network is to be allowed, then firms should be allowed to bid nationally because we will get to the same point but more quickly, more efficiently, and with higher revenue to the government.

To this list, we add an effect that cuts against national bidders.

3. There is a serious concern over a winner's curse effect. It will be exceptionally hard to place a sealed national bid before anything is known. On one side, there is the danger of

irrational bidding. Or, if all bidders are rational, then they should bid very conservatively and there is little likelihood of a national bid winning.[14]

Because of this ordering of the bidding, national bidders are at a severe informational disadvantage compared to regional bidders. They have to make a bid for all licenses before any of the information in the regional auctions has become public. As a result, national bidders for PCS licenses will have to be extremely wary of the winners' curse. Those who bid the most will ex post typically find themselves to have been overoptimistic regarding the value of the licenses. [The winner's curse is discussed in Appendix A of our first comments.]

The winner's curse is especially serious for the national bidders who must place sealed bids prior to any of the open auctions. The open bids will reveal a tremendous amount of information regarding the distribution of valuations among the bidders. If the valuations are much lower than expected, then a national bid will win. If the valuations are higher than expected, a national bid will be overtaken by the sum of the regional bids. In order to avoid the winners curse, it will be necessary to severely discount national bidding. As a result, it is quite unlikely that a firm will be able to bid aggressively enough to win a national license even if there are large economies of scale and scope.

The reason for this problem is the sequencing of the bids (national before regional) and the ensuing information asymmetry. A firm has the option of buying a national licenses through a series of regional bids. Since the regional auctions are open bidding and done in sequence, a firm learns important information each time a regional license is sold.

We believe that there is a variant of the national bidding scheme that goes a long way towards resolving most of the above problems and solves others as well. Some commentators, such as CTIA, have proposed opening national bids before regional auctions. We support going one step further: open up the national bidding.[15]

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[14] In the case of sealed bidding, we are more worried about irrationality. The winner's curse effect should be very strong here so it could easily overcome any bias.

[15] It is impossible to run either an English or a Japanese auction and keep the results secret. Our view is that the gains from opening up the bidding outweigh the cost of revealing the result.

Proposal #1: Conduct the pre-regional national license auction as open bidding, combining the bidding for the two licenses into one Japanese style auction.

Proposal #1': Conduct the pre-regional national license auction using simultaneous open English bidding for the A and B licenses.

Although we do not discuss it in detail, the similar arguments apply to allowing combinatorial bidding in the 10 MHz bands.

Proposal 2: In the BTA auctions, allow combinatorial bidding for MTA licenses using a simultaneous open Japanese or English auction for the E, F, and G MTA licenses. These MTA auctions would precede each group of BTA licenses. Similarly, national bidding could precede all of these auctions.

Proposal 1 is the direct extension of our original proposal for combining the A and B bands within an MTA into one Japanese style auction. Proposal 1' is the direct parallel of the Telephone and Data Systems' and Professor Weber's proposal for conducting the regional auctions: the prices for bands A and B are determined simultaneously.

In both cases, the idea is to create a symmetry between the bidding for national licenses and the subsequent regional bidding. This symmetry along with opening up the bidding accomplishes several objectives.

1. It reduces the winner's curse effect and allows people to bid more rationally for national licenses.

2. It provides more information to bidders before the start of the regional auctions.

3. It limits the ability of participants to bid above second-highest valuation (since you can't raise your own bid).[16] The comparison of regional to national bids is symmetric, Japanese to Japanese. We believe this symmetry together with limiting the bidding to the

[16] Note that this may result in leaving money on the table that the government might otherwise have collected. Here, we urge caution in interpreting this result. The government never loses money by allowing a national bid. National bids only win if they bring in more than the sum of the regional bids. By limiting the bidding, the government sometimes does not take in as much as it might have when a national license is awarded and it may fail to award a national license in some circumstances. This is the price of eliminating the bias and making the two bidding systems comparable.

second-highest valuation will solve the bias identified by Professors Milgrom and Wilson. This is a complicated and somewhat technical point and is discussed at length below.

Allowing national combinatorial bidding in an open auction solves some of the information concerns regarding sequential bidding in the regional auctions. Because the national bidding is open, everyone will learn a tremendous amount from that first auction. Not only will the bidding for the national licenses be more sensible, but it will help provide a baseline for the regional bidding.

Opening up the national bidding also helps address another problem raised in the first round of comments.

4. NYNEX does not want the New York region to go first. They are concerned about bidding without sufficient information. The advantage of opening up the national auction is that it will be of great help in providing a baseline value for the first regional auction.[17]

Having made the arguments in favor of combinatorial bidding for a national license, we should also point out the potential problems. We are keenly aware that no approach is without any liabilities. Knowing that bids will be open, a firm could bid low in a national auction to send a false signal. We do not want to encourage this type of gaming. We want to eliminate strategy and make the auction simple. If the national bids are not close to the expected regional winning bids, either higher or lower, then revealing this information could depress regional bidding in either case. If the national bids are lower than expected, firms could take this as a signal about the low value of the license and it could depress bidding in the regions. If the national bids are very high and it becomes clear that two national licenses will be awarded, this too might depress regional bidding. The reason is that beating the national bid seems impossible so that there is no point in playing the game.

Offsetting these disadvantages is that revealing the results of the national bidding prior to the regional auctions will provide valuable information. *This is more true when the bidding is open so that the participants will have less concern over the winner's curse.*

[17] We agree that New York should not go first. It would help to have some familiarity with the auction before selling New York. Our proposal is to start with Puerto Rico, Hawaii, and Alaska and then move to the mainland and proceed from big to small.

In fact, having national bidding precede regional bidding does more than just provide information. It provides a sort of guarantee to early regional bidders that they are not going to overpay for the license. *National bidding creates a reverse winner's curse result in the early auctions for regional licenses.* Once you know the result of the national bidding, you know that your regional bid will only matter if the sum total of all the winning regional bids exceeds that national total. So even if you are in one of the first regions in the auction, you do not have to worry about paying twice the price per pop as people in later regions. You know that if those other regions go at much lower prices than yours, you won't have to buy your franchise --- the result will be a national sale. The open national bidding will provide a rational basis for participants in the early regional auctions to bid more aggressively, to the benefit of the government. There is also an efficiency gain to this method, in that if there is both a common value and private value element to these franchises, then efficiency says that the franchise should go to the bidder with the highest private value component. By providing the national bidding information and protecting the regional bidders against the winner's curse, at least in part, the FCC would reduce the possibility that someone with a low private value but a high estimate of the common value (a speculator) would snap up one of these early important franchises.

We now turn to consider the somewhat technical issue of whether there is any bias in favor of national bidding and to understand the issue of the free-rider problem.

We agree that regional bidders are not going to be able to coordinate their bids so as to outbid a higher national player.[18] But does that imply there is any bias? We expect that the bidding for regional licenses will stop at second-highest valuation.[19] This second-highest valuation is the most the person is willing to pay for the license independent of how likely this bid is to win. Even if bidders knew that raising their bids by $1 would increase their chance of winning, this knowledge would have no effect on making them bid higher. In a Japanese auction, the bidding stops exactly at that point. In an English

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[18] Contrary to the NTIA suggestion, we do not want to encourage regional winners to then get together in coordinated way to try and increase their bids. There is too much potential for collusion and confusion.

[19] If the Commission adopts our proposal to combine MTA licenses into one auction, bidding will effectively stop at third highest valuation. Putting together the E, F, and G BTA bands, bidding will stop at the fourth-highest valuation. For ease of exposition, we continue with the single license auction in the text. The arguments remain the same with third-highest and fourth-highest substituted for second-highest.

auction with maximum bidding increments, the auction stops within one bidding increment of that point.[20] (You are not allowed to increase your own bid.)

Now consider the national bidding. The national bidding, running Japanese style, will also stop when the price reaches the valuation of the second-highest bidder. The second-highest bidder would not be willing to raise his or her bid even if that meant the difference between winning and losing since the price has now gone above the value of winning. You don't want to win at a higher price.

In this setting, neither side has the incentive to take into account the effect of their bid on increasing the chance that national or regional bidders will win a license. Each side's winning price is determined by the second-highest valuation, which is contingent on winning the license. The situation where the problems arose was in the case of sealed bidding where the winning bidders were allowed to go above the second-highest valuation in the sealed bid. By getting rid of that asymmetry, we eliminate the free-rider problem. The national bidding stops at the second-highest value and thus solves the Milgrom and Wilson bias, provides information about the value per POP that should help mitigate NYNEX's concern about having New York be the first regional auction, and provides more information during the national bidding to help prevent irrationality and the winner's curse. *Since there is no ultimate bias in favor of national bidders, then we need not be so worried that the regional bidders are not able to outbid a national bidder.*

In fact, taking the Milgrom and Wilson line of argument, there is reason to suspect that the national bidding will lose to the regional bidding unless there are real economies of scale or scope. The reason is as follows. The expected winning national bid is the expectation of the second highest sum of the regional values. In contrast, this bid has to beat the expectation of the sum of the second-highest regional values. Quite generally, the expectation of the maximum of a sum is less than the expected sum of the maximums. Once there are three or more bidders, it is also true that the expectation of second-highest sum is less than the sum of second-highest valuations. Of course, there are some assumptions that go into this result and they are presented along with a proof in Appendix B. The general point to make is that we do not expect that any one bidder would have the highest value in every region and absent that is unlikely to win a national license.

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[20] Recall from our first proposal that maximal bidding increments are a good idea. It keeps the auction less like a sealed bid. In fact, the best is the Japanese form of continuously increasing prices.

However, if there are sound economic reasons for assembling a national network, this changes the equation.[21]

Now that we have considered the issues associated with full combinatorial bidding, simultaneous bidding, stopping rules, and national combinatorial bidding, it is appropriate to reexamine our original proposal.

Proposed Auction Design

Our proposed auction format is close to the FCC's original design, which we believe was meant to be fair to all bidders. The main differences are that we are proposing to use a Japanese auction over the regional English auctions and the sealed-bid national auction. To the extent that most proposals advocated using English or Vickery auctions, we are close to the mainstream, but we think that the Japanese auction style is better because it eliminates jump bids and provides information about how many bidders are left in an auction. It also defines natural break points so that we can retain the benefits of sequential auctions, which the FCC originally proposed, while capturing some of the benefits of simultaneous auctions. We allow some simultaneity into the process by combining the bidding across the two 30 MHz licenses within an MTA, the three 10 MHz licenses within a BTA, and running the two designated license auctions simultaneous with the auction for the other three BTA licenses.

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[21] The reason to offer combinatorial bidding is that there is a presumption that there exist economies of scale and scope in a national license. If firms are not willing to pay more for a national network than for sum of regional licenses then it won't happen. It is not a set-aside. There are several potential sources of efficiency gain. A national license holder has an incentive to standardize the technology. This will lower the cost of all the components, both for the operator and for the consumer. Standardization will help give American firms an opportunity to establish a dominant position in manufacturing and export of this new technology. Becoming an international leader means moving quickly with R&D; if regional licenses need to be consolidated during a lengthy trading period in order to create national firms, the US may lose this opportunity. Standardization will also lower consumer switching costs; it will be easier for consumers to switch among providers if they are using compatible technologies. Reducing the cost of switching helps keep prices competitive. Because the network is large, the license holder has a greater incentive to engage in R&D. A small license holder may not be able to capture all the value of technological innovations, especially if other firms are using an incompatible technology. Furthermore, we believe that a national license will be created through mergers and affiliations even if the FCC does not auction such a bundle. This would be the worst way to get to the desired outcome. The process would be slower and this delay is costly to consumers. It took over a decade for the market to assemble a nearly national cellular network. Profits from assembling a national network go to the McCaws of the PCS world instead of going to the government. The government sacrifices additional revenue to lawyers and investment bankers who earn large transaction fees for assembling such a network. It takes longer, costs more and the government gets less. It may have the additional cost with regard to the United States establishing a world leadership position in setting standards for the next generation of wireless communication.

Keeping the Auction to a Manageable and Predictable Time Period

One potential problem with any auction design is that it might take too long to run the auctions. While bidding itself can be done quickly, the goal is to allow firms some time for reflection as the auction progresses. If the bidding is to be based on firms coming into the auction with reservation prices, we might as well do everything in a one-shot sealed bid format. Instead, we want to create an auction environment in which firms can revise their strategies and update their information as the auction proceeds. We think this is best done in a sequential auction.

We take the time issue very seriously and this motivated us to consider ways of adjusting the sequential auction design so as to shorten the auction period without reducing the time for reflection. In thinking about the time it would take to run a sequential auction, it is important to establish a realistic baseline. When Professor McAfee suggests that it would take over 10 years, running one auction per day, he fails to distinguish between auctions and multi-vitamins: only the latter need be taken once-a-day. Still, there are 2,538 licenses to be sold and there are useful ways to shorten the auction time.

Our original proposal was to reduce the 98 thirty MHz MTA auctions down to 49 by combining the bidding in the A and B bands. Similarly, we intended to reduce the 2,440 BTA auctions down to 1,464 by combining the bidding for the E, F, and G licenses.[22] Reconsidering the issue suggests that we could go further in combining bands: we believe that all 5 licenses within a single BTA could be auctioned off simultaneously.[23] This would reduce the total number of auctions down to 537. Since we believe that selling two nearly identical licenses would not take any longer than selling one (and that selling three nearly identical BTA licenses along with the designated BTA licenses would also take approximately the same amount of time as selling any one), the result of this combined bidding is to reduce the auction time by 79%.[24] The advantage of restricting the simultaneity to be within the two 30 MHz MTA licenses and the 5 licenses within a BTA is that there is much less of an interdependence problem: defaults, withdrawal of bids,

[22] Thus there would be three rounds of 488 BTA auctions, one for the C band, one for the D band, and one for the E, F, and G bands.

[23] Anyone could make a bid for the E, F, and G licenses. Only designated bidders could make a bid for the C and D licenses.

[24] Bidding itself is usually quick. The time delays are primarily caused by the time between auctions. Reducing the number of auctions from 2,538 to 537 represents a 79% savings.

and closing rules are all less problematic. Also, the scale of the simultaneity is much more manageable.

The proposal is to have 49 MTA auctions (combining A and B bands) in sequence followed by a sequence of 488 BTA license auctions (where there is simultaneous bidding on the C and D bands; and consolidated bidding on the E, F, and G bands). This is also very close to the proposal of Telephone and Data Systems, Inc. and Professor Weber.[25]

Putting together bands of a feather within an MTA or BTA is one form of simultaneity in the auction design. When it comes selling licenses across MTAs, we are proponents of sequential bidding (for reasons we explained in detail the earlier sections).

We now turn to explain in more detail how the sequencing might be done and still allow time for reflection. Since we were not clear about this in our first round of comments, some people have made the implicit assumption that the auction will allocate as much time to a 10 MHz license in Montana as to the auctioning of a 30 MHz license in New York. This is not what we have in mind. We do not have strong views on the exact method in which sequential auctions should occur, but we have some general ideas that could be implemented in several ways. One implementation is illustrated by the example below.

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[25] TDS and Weber suggested that we hold simultaneous *English* auctions for the A & B bands within an MTA, simultaneous auctions for the C and D bands, and then simultaneous auctions for the E, F, and G bands within a region. Thus they would have 49 MTA auctions followed by two rounds of 488 BTA auctions. We propose running the C and D auction at the same time as the E, F, and G auction: separate but simultaneous. Although there will be a restricted set of bidders for C and D, that does not prevent us from running these auctions concurrently. If this turns out to be impractical, running the C and D auctions simultaneously immediately followed by the E, F, and G auction is a very close substitute.

A second subtle difference between this approach and the TDS recommendation is that we propose using Japanese bidding and combining the licenses into one auction, where the high bidder get first choice. Whether combining the licenses into one auction is preferable to three simultaneous auctions depends on the answers to some engineering questions. If all bidders essentially agree that one band is more valuable than the other (because of incumbent effects) then there will not be any coordination question of who would choice what for first choice and who choose what for second. Everyone would know that they are initially bidding for second choice and then bidding a premium for first choice. The other engineering question is whether firms can easily network A & B bands (or whether this would create a checkerboard problem). It is our understanding that integrating across A & B or across E, F, and G is also straightforward.

In a larger context, these are small differences, variations on a theme. The one substantive difference between the TDS proposal and our proposal in that we would allow national combinatorial bidding prior the sequence of simultaneous A & B auctions and MTA combinatorial bidding prior to the sequence of BTA auctions. Following their concerns, not only would the winning result be announced prior to the regional bidding, but the entire auction would be open. These points are discussed in the previous section on national combinatorial bidding.

Note that our example below does not include national combinatorial bidding. There are two reasons for delaying this discussion. Adding national combinatorial bidding complicates the auction and we wish to present the base case in its starkest form (before adding any refinements).

The 49 MTA auctions sequencing: simultaneous bidding on A & B bands .

One possibility is to begin with Puerto Rico, Hawaii and Alaska. As geographically separate regions from the mainland, they can be valued separately from being part a regional or national network. These auctions will give bidders (and observers) some useful experience with the auction format.

We then proceed from big to small. For the very biggest markets, the bidding is spread out over 4-5 brief sessions during 2-3 days. The idea is to stop the first session of bidding when there are only 10 bidders left. *Here is where the Japanese bidding format proves to be particularly useful.*

Recall that under Japanese bidding, all active bidders must announce themselves. Bidding proceeds as an electronic clock displays continuously increasing prices. Bidders drop out and can't reenter; bidding ends when there are only as many bidders left as licenses. Since active bidders must indicate their participation (whether through a raised hand or electronically), we always know exactly how many bidders are willing to pay the current price.[26]

Bidding could go quite quickly to bring the number of active bidders down to ten. In this initial stage, people will really be acting according to a reservation price strategy. Once there are only ten bidders left, the auction is temporarily suspended and the ten bidders are given several hours to consult with their home base. In the afternoon, Japanese bidding continues until there are only 6 bidders left to compete for the two licenses. In the morning of the second day, Japanese bidding continues until only 4 bidders are left to compete for the two licenses. Finally, in the afternoon of the second day, Japanese

[26] In contrast, in an English action, there is no way of knowing how many people are still truly active.

bidding continues until only 2 winning bidders are left.[27] [There is then a short second auction to determine who get first choice; we discuss in the section on auction details that follows.] This system would allow bidders three opportunities to consult with top management during the auction about how to bid. It also guarantees that the auction makes a certain amount of progress in each of the sessions. It allows us to predict with certainty when an auction will come up and when it will close.

There is still the issue of how to get the 49 auctions down to a short time frame. The following schedule guarantees that all 98 MTA licenses would be sold in two weeks.[28] This is done by partially overlapping some of the bidding.[29] This overlap is a small step in the direction of a simultaneous auction. We hope that it is seen as having some of the benefits of simultaneous bidding and we recognize that it also has some of the costs. Since it is a limited form of simultaneity, both the benefits and the costs are also limited.

In the example, boldface indicates the end of an auction.

	Morning Session	**Afternoon Session**
Week 1 (auction 18 pair of licenses)		
Day 1		
	Puerto Rico (down to 10)	**Puerto Rico (down to 2, ends)**
	Alaska (down to 10)	**Alaska (down to 2, ends)**
	Hawaii (down to 10)	**Hawaii (down to 2, ends)**
	Short Break	Short Break
	New York (down to 10)	New York (down to 6)
		Los Angeles (down to 10)

[27] For smaller markets, the number of stages could be reduced from 4 to 2, or even 1. The breaks could be based on money. For example, the first stage goes on until the bidding reaches at least 30 million dollars even if that reduces the number of bidders to well below 10, the second stage goes up to 50 million, etc.

[28] If desired, the process could be slowed down by reducing the number of new licenses introduced at each session.

[29] For ease of exposition, we identify an MTAs by one of the major cities that they contain. Following Puerto Rico, Hawaii, and Alaska, the order of the auction would be determined by population covered, which may not correspond exactly with the example.

Day 2		
	New York (down to 4)	**New York (down to 2, ends)**
	Short Break	Short Break
	Los Angeles (down to 6)	Los Angeles (down to 4)
	Short Break	Short Break
	Chicago (down to 10)	Chicago (down to 6)
		Short Break
		Dallas (down to 10)
Day 3	**Los Angeles (ends)**	**Chicago (ends)**
	Short Break	Short Break
	Chicago (down to 4)	Dallas (down to 4)
	Short Break	Short Break
	Dallas (down to 6)	Miami (down to 4)
	Short Break	Short Break
	Miami (down to 8)	Denver (down to 4)
	Short Break	Short Break
	Denver (down to 8)	San Francisco (down to 4)
	Short Break	Short Break
	San Francisco (down to 8)	Phoenix (down to 8)
		Short Break
		Cleveland (down to 8)
		Short Break
		Philadelphia (down to 8)
Day 4	**Finish previous 3 MTAs**	**Finish 3 morning MTAs**
	Add 3 new MTAs	Add 3 new MTAs
	(bring each down to 8)	(bring each down to 8)
Day 5	Same as above	Same as above
Week 2 (auction 31 pair of licenses)		
Day 6	Same as above	Same as above
Day 7	Same as above	Same as above

Day 8	Same as above	Same as above
Day 9	Same as above	Same as above
Day 10	**Finish previous 3 MTAs** Add 4 new MTAs (bring each down to 8)	**Finish 4 morning MTAs**

The 488 BTA auctions sequencing: simultaneous bidding on C, D, E, F, and G bands .

Our view is that the BTA licenses are sufficiently smaller in magnitude that it might not be necessary to have extended bidding on each license. It is also natural to group the sale of BTA licenses to those within an MTA. Thus the auction could run each group of license sales to completion in one session. For the first 9 sessions [days 1, 2, 3, 4, and 5 (morning)], all the BTAs within that session's MTA would be sold in sequence. For the following 21 sessions, all the BTAs within two MTAs would be sold.

Since the average MTA has 10 BTA licenses and there are 5 bands, selling off all licenses within 2 MTA regions would typically involve 100 auctions per session. But remember that in each case, bidding in 5 of the auctions is happening simultaneously so that there are really only 20 sequential auctions. Since the actual bidding in an auction can be completed in 5 minutes, the total bidding time is less than two hours; that leaves an hour an a half for lunch and a little over four and one-half more hours for breaks between bidding.

Implicit in this view is that by the fourth week, bidders will come to the auction with reservation prices. Note that it is only in the fourth week of the auction that there are 40 auctions in a day. In the first week, there are only 18 altogether, in the second week 31. In the third week, we move to the BTA licenses and the pace picks up to 20 auctions daily. By the fourth and fifth weeks, buyers will be quite experienced with the process and relatively little new information will be forthcoming. It seems reasonable to us that there will be much less need for consultation in the fourth and fifth weeks.

There are several advantages of having such a fixed and predictable auction schedule. People who are only interested in a limited number of licenses need only participate in

the relevant days. Firms can plan their schedules around the auction, knowing in advance when everything will be over. The Commission can also predict the completion date for the auction.

Using the Japanese bidding format gives the FCC control over the process. The FCC can decide what is a reasonable pace and then ensure that the auction proceeds at that speed. The reason why the FCC has this control is that it has a sensible way to interrupt the bidding and then restart the bidding. It also has control over the simultaneity. The FCC could allow more or less overlap in the bidding. It could extend the number of rounds before the bidding is closed. Alternatively, it could decide that all MTA licenses should first be brought down to ten (or some other number of) bidders and then proceed to close them one at a time. The common element in all these variations is that the FCC has control.

Now that we have described the main points of the auction, we turn to consider some of the very specific details.

TECHNICAL DETAILS

Modifications of Japanese Bidding Style.

We are in favor of having the price rise in a continuous way, such as a clock. This could be supplemented with an LED board that displays the number of active bidders. The board could also display or not display the identities of the active bidders (perhaps when there are only 10 remaining).[30]

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[30] In contrast to others, we are not convinced that identification of bidders is a bad idea. It will facilitate efficient cooperation as much as collusion. Having several rounds of Japanese bidding, we will allow losers to work out deals with the remaining bidders that may enhance the final bidding. For example, if your primary strategy is to be in New York but you also want to reach New Jersey, you might indicate a willingness to take a minority stake in a New Jersey bidding group which will work out a networking agreement with you. This is easier to do if you know who the bidders for New Jersey actually are. While there is also some potential for collusion in the final round if there are only 4 bidders for 2 licenses, we note that the collusion will have to be arranged in a relatively short period of time, especially compared to the McAfee and Milgrom-Wilson schemes. We tend to agree with Milgrom and Wilson that there will be enough competition and conflict of interest that, at least if an auction is done over a short period of time, collusion is quite unlikely.

Furthermore, knowing you are up against a large national company may not make a firm feel that its chances of making money in a particular market are worsened. For example, you may be able to free-ride on that firm's research in estimating the demand in that market. You may be more confident that they will not start cutting prices because of a cash flow crisis. You may feel that as part of a large organization they will not be as effective a competitor as a small business not encumbered by national labor contracts and the like. For example, in recent years national companies such as Chevron Oil and Safeway Supermarkets have sold off properties on which they could not make money as a large operator, to smaller local organizations that have been able to operate profitably. Finally, it is a bit of a mystery of why you

An advantage of this technique is that the clock speed could be adjusted so that the auctions proceed at any desired speed. We could start the clock rising very quickly and then slow it down as the number of bidders shrinks. Thus with 190 bidders left there is no need to proceed slowly. However, where there are only fifteen bidders left, it makes sense to go more slowly.

Bidders could indicate that they are active in several ways. They could indicate this manually by holding up a card. They could do this semi-electronically by having a switch that remains active until they turn it off; think of a light switch; all lights start green and bidders can flick the switch off to drop out of the bidding.

A third variation of Japanese bidding might be the most attractive when there are a small number of bidders left, such as ten or fewer. Here the idea would be to establish a small bidding increment and then order the bidders in some sequence. The auctioneer would go to each of the bidders in turn and ask then if they are willing to raise the bid by this pre-designated increment. Anyone who is not willing to raise the bid must then drop out. The auctioneer goes around to all the bidders before returning to repeat the process. The bidding would be very quick because bidders could only choose between saying yes and dropping out. The other advantage of this approach is that it allows more flexibility when we are selling items that are not quite identical. Thus if there is simultaneous bidding on the E, F, and G licenses, bidders would be allowed to choice the license on which to raise the bid (unless they already have a winning bid).[31]

Deposits

Breaking up the auction into several rounds allows the FCC to get increased level of deposits from the active bidders. The deposit fee could be increased by some number of pennies per pop per MHz in each round of the bidding.

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would be more deterred on average in the bidding if you knew you faced a large competitor in one market and a small competitor in another, rather than a 50-50 chance of a large competitor in each market.

[31] It is a little more complicated to use a Japanese auction when there are 5 BTA license auctions going on at once. One idea is to have three clocks, one for band C, one for band D, and one for bands E, F, and G. Designated bidders have two cards they can hold up signaling participation in each of the C and D auctions. There is a third card, available to everyone, for participation in the E, F, and G auction. The auctions could be synchronized in the following way. If one of the auctions falls down to 10 bidders that clock is stopped until the other auctions are also at that point. The clocks start again and continue until the one auction falls to 6 bidders; once again the clock is stopped while the others catch up.

Simultaneous Drop Out

We also need a provision for what happens if there is simultaneous withdrawal at the beginning of a round. What happens if, during the bidding break, many of the bidders reconsider and would like to immediately exit the bidding. This is not a problem provided that enough bidders remain active (at least as many as there are licenses). But, in the unlikely event that there are too few bidders for licenses, the auction rules must state what will happen in such a scenario. Here is our proposal. We could open up the auction to any bidders who previously dropped out. If that fails to draw any or enough bidders, we then enter into a penalty auction. For example, imagine that there are four bidders, none of whom want the two licenses available at the last price. Then we start a penalty auction with a continuously rising penalty. Firms drop out of the penalty auction by agreeing to buy the license at the previous closing price. In our four bidder example, two will end up paying identical penalties and the other two will be forced to buy the licenses. That is, the penalty amount rises from zero until only two bidders are still in the Japanese penalty auction. The two auction "winners" pay the final penalty amount. The two "non-winners" are forced to buy the license at the final price. Instead of paying the penalty to the government, it could be paid to the other bidders, a zero-sum penalty. That is, the government gets the final price for both the licenses and the two who pay penalties pay them to the two who get the licenses.

National Combinatorial Bidding

The combinatorial bidding for a national 30 MHz MTA license would done prior to the series of regional MTA auctions. This auction might proceed over three sessions. The first session would reduce the number of bidders to 8. The second session would bring the number down to 4. The final session would determine the two highest bidders. Note that this final session could overlap with the beginning of Day 1 in the region auction sequence. Thus the three session adds only one extra day to the process. Similarly, before each sequence of BTA auctions within an MTA, there could be a Japanese auction for the combined MTA 10 MHz license. Prior to the commencement of the BTA auctions in the third week, there could be a Japanese auction for the possible sale of a national 10 MHz license.

Comparing National to Regional Bids; First Choice; Second Choice

In our bidding scheme, the following priority principles apply to the 30 MHz licenses: First, we do a Japanese auction to get down to 2 national licenses, at a price that we will

label N3, indicating the third-highest reservation value. We then continue to see who should get priority if there is only one national license. The two winning bidders continue with the Japanese auction until one drops out, at a price that we denote by N2. We do the equivalent two-stage auction in each region, getting prices $R3_i$ and $R2_i$ for each region i that, when summed across all regions, aggregate to R3 and R2. If N3 is greater than R2, we award 2 national licenses, at price N3. The national bidders then both pay N3. If R3 is greater than N2, then we award 2 regional licenses, with each regional bidder paying $R3_i$. Finally, in the intermediate cases, we award one national license at N2 and one regional license in each market at the $R2_i$ price. (Note that if the national winner is also among the top 2 in any region, then the price for the other winner in that region could be the third-highest regional price.) The point of bidding for priority, as opposed to picking the A or B license, is that we believe that firms care more about whether they will be awarded a license than whether they will get the A or B block. Bidding for first choice does not allow a participant who is relatively indifferent between the two block to indicate a strong preference for getting either license if only one license is available. We believe that this scheme is immune to collusion among the top two bidders in a region in a way that would help them both get licenses. If only one of them is to get a license, there is more of a conflict of interest and less chance of collusion.

Once the two 30 MHz winners have been selected in a region, we would (separately) auction off the right to choose first between the A and B license and the payment premium. This decision is separate from the value of getting a license in the market, and could be dealt with separately. Similarly, the top two national winners have one final auction to determine who gets the A/B choice and the relevant payment premium. If the priority bidding awards both licenses nationally, then the A and B allocation is as decided by the outcome of the final national bid. If the priority bidding awards both licenses regionally, then the A and B allocations are decided by the outcome of the first-choice bidding in each region. In the mixed allocation case, we add the relevant first-choice premium to N2 and R2 and the side with the higher total gets first choice and pays its premium, while the other side gets second choice and just pays either N2 or R2.

For the E, F, and G 10 MHz licenses, we would also want to do something simple, even if it were not optimal. One possibility, in keeping with the Japanese motif, is to have the 3 bidders begin. The first one who drops out gets third choice and pays nothing extra. The second one who drops out gets second choice and pays the amount at which the third

bidder dropped out. The remaining bidder pays the amount quoted at the end of the auction and gets first choice.

Appendix A

Further comments on

(1) The NTIA proposal and

(2) Professor McAfee's first and second round reply comments.

(1) The NTIA proposal.

We began this document with a discussion of some of the problems associated with creating a simultaneous auction with all possible combinatorial bidding allowed. Having explained why we disagree with the NTIA's conclusion, here we examine some of the arguments used to reach their conclusion.

NTIA criticizes the sequential bidding process proposed by the FCC because "losing bidders for the first license may not bid as aggressively in a subsequent auction for an adjacent license, so the winner of the first license will not have to bid as high in order to win the second [page 11]." They argue that this will lead to inefficiencies and will cost the government revenue. Yet, if bidders anticipate this effect, then sequential bidding will not necessarily lead to lower revenue. Because the firm that wins the first license can anticipate its advantage in the second auction, it is willing to pay more for the first license than it would in isolation. The value of winning the first license also includes the value of having an advantage in the subsequent bidding. The size of this advantage depends on the importance of interdependence. If interdependence in values is small, this effect will not be important. But, when it is large, then the advantage in the second auction will also be large and this implies that the winner of the first license is also very likely to win the second. Bidders anticipating this relationship will understand the true value of winning the first license and bid more aggressively accordingly. When it makes sense to have the licenses bundled, even sequential bidding will lead to a bundled outcome. Is it the ideal way to bundle? No. The end result may be inefficient. But, running all auctions simultaneously leads to its own inefficiencies. The question is: which set of inefficiencies is worse than the other?

On page 13, NTIA argues that failure to allow iterative bidding may result in an inefficient outcome. Here the inefficiency arises because the oral bidders in the sequential

regional auctions are not given a chance to coordinate their bidding strategies in order to defeat a national bid. We believe the idea that coordinated bidding strategies would help is misguided. There are two reasons. First, the free-rider problem is almost insurmountable. There is no simple way to coordinate 49 people raising their bids while protecting against the possibility of bidding cartels and collusion. The proposal is almost an invitation for firms to form a bidding ring and coordinate their strategies. We think the cure is worse that than the disease.[32]

If there is no ultimate bias in favor of national bidders, then we need not be so worried that the regional bidders are not able to outbid a national bidder. In the case of sealed national bids, there is a tremendous winner's curse problem (because the bidding is first and is sealed) that will depress national bids. This should dominate any small bias from the free-rider problem.[33] Furthermore, both biases can be greatly reduced by switching the national combinatorial bidding to an open Japanese format. Recall that in a Japanese auction, bidding will stop at the second-highest valuation. Provided that the national bidding also stops at the second highest valuation, this seems to be a fair fight. Neither side can raise their bid to take into account the increased chance of winning. The second-highest bidder drops out when the price reaches his or her reservation value and this reservation value is made on the presumption that this is a winning bid. Once again, provided that the national bidding stops at the second-highest valuation, there is no bias either for or against the national bidder. There is no free-rider problem. The second-highest valuation would not want to raise his or her bid even if that would change the outcome. Of course, like all proposed schemes, there remains a potential inefficiency. We are choosing between national and regional licenses by comparing the second-highest valuations and not the highest valuations. Alas, the order of comparisons may not always be the same. Absent moving to the efficient auction mechanism proposed in Appendix B of our first report, there is no solution to this pervasive problem. In most auction formats, bidders have an incentive to act strategically; there is no simple way to induce participants to reveal their true valuations so that the right comparisons can always be made and an efficient allocation be attained.

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[32] Recall from the text that it is also almost impossible to satisfy budget constraints when all possible combinatorial bidding is allowed. Or, bidders would have to be allowed to withdraw bids. Both are very serious problems.

[33] The free-rider problem only induces a bias to the extent that rational bidding stops at the second-highest valuation while national bidding could go up to the first-highest valuation. With a large number of regional bidder, the difference between the two number is likely to be quite small.

On pages 12--14 of Appendix A, the authors argue "Due to the lack of research, it is not clear whether the efficiency and revenue characteristics of the single-unit forms will carry over to their multiple unit counterparts." The authors go on to show that a standard Vickrey or second price auction might not reach an efficient result when firms are interested in purchasing more than one unit. There is a simple extension of the Vickrey auction when buyers seek to purchase multiple units. A winning bidder who buys two units pays the sum of the two highest losing bids, excluding his or her own. Similarly, a buyer who wins three units bids, pays the sum of the three highest losing bids excluding his or her own. This is an application of the general principle outlined in Appendix B of our first report. The mechanism that always leads to an efficient allocation (and truthful or non-strategic) revelation of valuations is to assign licenses so as to maximize total revenue and then allow bidders to each keep the surplus that they bring into the auction. The surplus a bidder brings is the extra revenue generated by his or her bidding. To illustrate this principle in the case of a Vickrey auction where buyers can purchase multiple units: How much extra revenue does a buyer who wins two items bring to the auction? Without that buyer, the items would have been sold to the two highest losing bids (excluding his or her own losing bids). If the winning bidder pays just that amount, the allocation will always be efficient.

But there are some serious problems with this efficient mechanism. First, it does not do a good job accommodating budget constraints. Second, it is far from transparent. Although it does a fine job allocating licenses, it does not provide the desired feedback to help firms adjust their bidding strategy. Perhaps worst of all, if this is used in an iterative manner, what are losing bids in the first round become winning bids later on (because some coalitions will get outbid and your regional bid then become winning again) and the end result is a loss of control over bidding strategies --- once again the opposite of the desired result.

A confusing point in the NTIA document concerns their characterization of the total revenue in the common value auction as the number of bidders increases [p. 25]. They note that the "padding" (or what might better be called "shading") of the bidding increases as the number of bidders gets large. They then conclude that "beyond some unknown number of bidders, the incremental benefit to revenues of increasing the number of bidders is greater in a private than in a common value auction." *Even so, it is still the case that having more bidders in a common value auction raises the expected*

revenue to the seller. The increase in shading is more than compensated for by the increase in the number of bidders. The question is whether the expected highest bid among N bidders will be above or below the expected highest bid among N+1 bidders where in the N+1 bidder auction, bids are shaded slightly more. The results of auction theory show that the presence of the additional bidder more than compensates for the slight amount of extra shading.

Section B (on p. 26) of the NTIA report focuses on the issue of the extent to which these licenses will be private or common value. While there are some incumbency effects and interconnection of market and competitive effects, the authors generally conclude (p. 65) "Although there are common value features in the PCS auction, it will occur in what is primarily a private value setting." Although this is nothing that we can prove, we believe that the common value element in the PCS auction will be a more important source of variation than the dispersion of private values. The primary common component is the value of this new technology. What will PCS be? The ability of PCS networks to provide seamless roaming is still unresolved. The ability to employ compression technique to expand capacity is also unknown. The ex-post competitiveness of the market is another common unknown. Consumer demand for this product is a further unknown. At present, only 4% of the population has a cellular phone. How much does the other 96% value this service? How hard will it be to convert cellular customers to PCS? Will cellular providers convert to digital and effectively become two more PCS providers? How will the cellular versus PCS competition shake out? Will there be a national PCS provider? How expensive will it be to develop the PCS technology and infrastructure? Will there be compatibility problems in the networks? The answer to all of these questions is a common concern to all potential PCS providers. While they may each care about the answer is different ways, we believe that the large scope of common uncertainty suggests a tremendous element of common valuations. There will certainly be systematic differences among providers, but those will be small compared to the large uncertainties about just what this system and technology is worth. We need to look no further than the CBO office report which is predicts the value of these licenses only within 5 billion dollars. The cellular phone industry provides some empirical evidence of the common value nature of this business. The fact that the stock market value of cellular license properties have all done exceptionally well in the last three years (while some have done better than others) shows the large component of common value in the value of wireless communication.

(2i) Response to Professor McAfee's first round reply comments.

Professor McAfee on p. 13 of his original comments makes the argument that national bidding will reduce the amount of revenue available to the government and create inefficiencies. In his example there are three bidders, East (E), West (W), and National (N).

	Region Valuation		
Bidder	East	West	National
East	2	1	3
West	1	2	3
National	1.6	1.6	3.3

In this auction, the national bidder is supposed to sit out of the regional bidding (in order not to compete with himself or herself) and thus the regional licenses are sold for 1 billion each. The national player wins the national auction at 3 billion (and a penny) and this exceeds the sum of the regional winning bids. But it is inefficient since the sum of the maximal regional valuations is 4 billion which is more than the National player's valuation.

It is important to put this example in perspective. In any system other than a Groves-like mechanism (see Appendix B of our first comments) there is going to be a gaming opportunity and therefore a chance to make up an example that illustrates almost any point.

One concern regarding the generality of the McAfee example is that he ignores the possibility of license resale. As Professors Milgrom and Wilson argue, resale is an important factor in making sure that any system without combinatorial bidding will capture the efficiencies inherent in networking.

Under the McAfee example, if resale is permitted, we expect national bidding to lead to an efficient outcome. Under the standard economist's model of bargaining with complete information, we would expect the government to collect $3.6 billion from either East or West in the national bidding (both would bid that much), with the winner reselling the license that it values least to the loser for $1.8 billion, or halfway between the $2 billion value of the other bidder and the $1.6 billion value of firm N. Both E and W walk away

from this auction with .2 in surplus so neither of them would have an incentive to walk out of the initial national bidding. With only regional bidding, the bids would presumably go to 1.8 billion in each region, so efficiency would be achieved at the same revenue to the government.

Now assume, as does McAfee, that the national bidder has a value of $4.1 billion. McAfee contends that firm N will then win the bidding with regional bids of $2 billion each, if no national licenses are allowed, but will pay $3 billion if it is allowed to make a national bid. But if resale is allowed, then both E and W will be able to bid $4 billion for a national license also, since they could get at least that much with competitive resale among both the other regional bidder and the national bidder. So again, McAfee's assumption that the national bidding will be costly to the government depends on the no-resale assumption which he either did not notice or else neglected to mention.

Furthermore, even without resale, McAfee has chosen a very fragile equilibrium[34] which does not stand up even under his own proposed bidding rules. For example, assume that the bidding has gone as he suggests, and the current high bids are $3.0 billion for the national license and $1.0 billion for each regional license. Then wouldn't it make sense for bidder E in region E to raise his bid by 5% in order to keep the auction going. If he stops bidding, he gets nothing. Keeping the auction alive has no cost to him and this gives W the option of raising his bid by 5%. This minimal bidding increments proceeds until both E and W are up to $1.65 billion. At that point, both E and W getting licenses for just over the national value of firm N of $3.3 billion. Once E makes this increased bid (and then stops bidding), the only equilibrium is for W to raise his bid and for the regional bidders to win.

Of course, the chance for such coordination is much less when there are 49 licenses, and even half a dozen major ones. That is why we deal with the free-rider problem in our auction design. But in an example such as McAfee's, the reasons why the national bidder N is able to stay out of the regional bidding (full information and a small number of markets) are exactly the reasons the equilibrium analysis doesn't hold together. If he allowed for 49 markets and incomplete information about other bidders' values, then it would take a gutsy national bidder to withdraw from the regional bidding in the hopes that this would make the marginal difference for winning a national license. This would not be the kind of strategy that would be easy to explain to shareholders if it failed.

[34] It requires the use of what are called "weakly-dominated strategies".